MOQS – MOlecular Quantum Simulations

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| **Topic title** | Hybrid quantum-classical molecular quantum simulations with Rydberg qubits |
| **Main host institution** | University of Strasbourg, France<br>http://en.unistra.fr |
| **Supervisor** | Shannon Whitlock / eqm.unistra.fr<br>whitlock@unistra.fr |
| **Co-Supervisor** | Servaas Kokkelmans, TU Eindhoven, Holland<br>s.kokkelmans@tue.nl |
| **Mentor**[1] | Michael Marthaler, HQS Quantum Simulations, Germany<br>michael.marthaler@quantumsimulations.de |
| **Secondment institutions** | Technical University Eindhoven, The Netherlands (3 Months)<br>BASF, Germany (3 Months) |
| **Preferred starting date** | Before May 2021 |

**Topic description**

In this experimental project we will develop experimental tools and techniques for solving important molecular spectra and dynamics problems using a Rydberg quantum simulator. Specifically we will investigate the use of variational quantum algorithms : a hybrid quantum-classical approach to quantum computing suited to today's « noisy intermediate scale quantum » devices. Typically a problem of interest is encoded as a Hamiltonian and then a programmable quantum processor is used to generate trial wavefunctions. Measurements are then made and the expectation values are used to calculate the objective function for a classical feedback loop. Planned applications include solving for the ground states of small molecules and optimizing « molecular » quantum dynamics by tailoring the spatial geometries and interactions between the atoms. There will be a high degree of interaction between experimental and theoretical groups throughout the project. About the Exotic Quantum Matter group: We offer the possibility to do exciting experiments embedded in a culturally and scientifically rich research environment, situated alongside the Rhine river on the French-German border. We host a state-of-the-art quantum simulator based on optically trapped Rydberg atom qubits. These systems are uniquely suited for studying quantum many-body problems, and applications towards quantum computing. For more information and recent publications, visit: eqm.unistra.fr

**Recommended applicant's profile**

Candidates should have a master degree in physics with a strong academic background in quantum physics and atomic, molecular and optical physics, as well as experimental research experience in the field of ultracold atoms.

[1] Mentor: The primary role of the mentors will be to identify and facilitate specific training objectives, advise on any problems faced by the ESR, including career matters with an external perspective and provide mediation in the case of disputes.

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